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DISCUSSION OF CONSUMPTIVE USE IN THE RIO GRANDE BASIN

(Published in November, 1951)

By Isom H. Hale and George A. Whetstone; H. R. McDonald; and Robert L. Lowry

IRRIGATION AND DRAINAGE DIVISION

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DISCUSSION

ISOM H. HALE,[5] AND GEORGE A. WHETSTONE,[6] ASSOCIATE MEMBERS, ASCE.
—It has long been known that the three-point program defined at the end of this paper is effective. The data in this paper—applying as they do to 15 years of unregulated flow followed by nearly 40 years of progressively increasing regulation—fill a gap in hydrologic literature by demonstrating, quantitatively, a measure of this effectiveness.

Another phase of nonbeneficial use, upstream from El Paso deserves to be recorded. As Mr. Lowry has mentioned, Elephant Butte Dam was finished in 1915, and the reservoir functioned for many years thereafter as a single-purpose seasonal storage facility. From 1938 to 1940 a power plant was added at this dam, and a second dam was built 20 miles downstream, creating Caballo Reservoir with a volume of 346,000 acre-ft of which 246,000 acre-ft were reserved for regulating power releases from Elephant Butte Dam.

Although Caballo Dam and Reservoir have undoutedly been a means of permitting the operation of the power plant at Elephant Butte throughout the year rather than only in irrigation season, they have also had the adverse effect of creating a large lake in an area with a very high evaporation rate. The average annual storage in Caballo Reservoir is 122,400 acre-ft.[7] The surface area at this capacity is about 6,350 acres. The average annual reservoir loss due to evaporation, minus rainfall, from 1943 to 1950, inclusive, was about 42,600 acre-ft, not including losses during winter months to waters in transit from Elephant Butte to Caballo.

It would seem to the writers that a better solution (and one which could still be employed to advantage) would be to substitute for Caballo Reservoir, with its seasonal storage, a new daily or weekly reregulating reservoir with a volume of perhaps 5,000 acre-ft (the maximum daily power releases having been from 2,400 to 3,000 acre-ft) and then to operate Elephant Butte as a pumped-storage installation. A further advantage of this procedure would be that waters stored in Caballo Reservoir following flood periods would not necessarily have to be released to provide storage for power releases during the following off-irrigation season. This may be illustrated by the period following the 1942 season when Caballo Reservoir was almost full and facing a period of power releases from Elephant Butte Dam with no place to store the water. In 1951, there was an extreme need for such water.

It is instructive to compare the past operation of Elephant Butte since 1942 with that outlined in this discussion—that is, using pumped storage facilities at Elephant Butte, in lieu of Caballo Dam, for regulating power releases. The release lost during the period following the 1941–1942 floods, due to power production at Elephant Butte, was at least 75,000 acre-ft. The

NOTE.—This paper by Robert L. Lowry was published in November, 1951, as *Proceedings-Separate No. 97*. The numbering of footnotes and tables in this Separate is a continuation of the consecutive numbering used in the original paper.

[5] Hydr. Engr., International Boundary and Water Comm., El Paso, Tex.

[6] Associate Prof., Civ. Eng., Texas Technological College, Lubbock, Tex.

[7] *Water Bulletin No. 19*, International Boundary and Water Comm., El Paso, Tex.

average annual prevented losses, due to avoiding the annual use of Caballo storage for power releases would have been approximately 20,000 acre-ft during the 8-yr period, 1943–1950, or a total of 160,000 acre-ft. This is very conservative since 20,000 acre-ft are not quite half as much as the average annual loss computed for Caballo Reservoir for the period since 1942. This means that approximately 235,000 acre-ft of additional water would have been in Elephant Butte Reservoir at the beginning of 1951 while at the same time serving project lands with the same volume of water during the period. In addition, the water that was in Caballo at the beginning of the year would have been in Elephant Butte. Due to the increase in stored waters in Elephant Butte, and resulting increase in power heads, the net effect on electrical energy potentials would have been an increase throughout the period with the same quantity of water released. Pumping operations on a day after day basis would have been necessary only during the off-irrigation season, October to February, or on an average of five months of each year.

H. R. McDONALD,[8] A. M. ASCE.—The data in this paper demonstrate the magnitude of nonbeneficial depletions in a stream channel under natural or virgin conditions. The methods that have been used so successfully in the El Paso-Juárez Valley undoubtedly could be applied to many other western streams with at least some degree of success.

Mr. Lowry has shown that there has been no significant change in total stream depletions in the El Paso-Juárez Valley since 1915 following the regulation of stream flow by Elephant Butte Reservoir, although the irrigated acreage has increased more than threefold. There is probably no important area not yet developed where such large reductions in nonbeneficial uses could be effected. However, sound planning for the development of water resources will require that wherever salvage can be made economically, such measures must be considered carefully.

TABLE 5.—TOTAL DISSOLVED SOLIDS (MEAN VALUES, 1931 TO 1936)

Gaging station	Tons per acre-ft	Total tons
Below Elephant Butte Dam..... (No large contiguous irrigated areas in this reach)	0.81	619,909
Leasburg Dam, New Mexico..... (Large contiguous areas irrigated in this reach. No important tributary inflow)	0.87	647,406
El Paso (Courchesne)..... (Large contiguous irrigated areas in this reach)	1.22	637,968
Fabens-Tornillo..... (Large contiguous irrigated areas in this reach)	1.93	496,014
Fort Quitman.....	2.75	473,129

Col. 10, Table 1, records the outflows at Fort Quitman, which are noted to have been decreasing since about 1905. The average outflow from 1937 to 1948 (189,700 acre-ft) may have equaled or exceeded the "economic minimum" mentioned by Mr. Lowry in his closing paragraph. It is generally recognized that, in order to maintain crop production and to prevent the development of saline or alkali soils, an approximate balance must occur between the average inflow and outflow of the total soluble salts. This balance may be only approximate because of the base exchange complex between chemical constituents

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contained in the soil and in the water that is applied. Normally the return flow from an irrigation project is much more highly mineralized than the irrigation water applied and contains relatively high percentages of the more soluble salts. However, there is a point beyond which the salt concentration cannot be tolerated permanently. In effect, this fact places a limit on the extent of beneficial uses and thereby the irrigated acreage that can be developed, unless further reductions in nonbeneficial consumptive uses can be made.

Table 5 shows the changes in total dissolved solids at gaging stations along the Rio Grande from Elephant Butte Dam to Fort Quitman.[9]

ROBERT L. LOWRY,[10] M. ASCE.—In general, the discussions of this paper have indicated general agreement with the main theme of the paper, which is that—future expansion in irrigation throughout the Southwest is mostly limited to such savings in present nonbeneficial uses of water as may be possible. As stated by Messrs. Hale and Whetstone, there is ample opportunity to effect a saving in some instances by a more efficient operation of the existing reservoir systems. The method outlined for a possible saving of water on the Rio Grande, which would greatly benefit the irrigated area that is the subject of this paper, shows promise of something worth while. It is to be hoped that the authorities of the facilities involved will give the suggestion proper consideration.

TABLE 6.—TOTAL DISSOLVED SOLIDS (MEAN VALUES, 1931 TO 1949, INCLUSIVE)

Gaging station	Tons per acre-ft	Total tons
Below Caballo Dam	0.71	589,000
Leasburg Dam	....	610,000
El Paso	1.11	634,000
Fabens-Tornillo	....	....
Fort Quitman	2.31	543,000

The question raised by Mr. McDonald concerning the salt balance in the irrigated lands in this reach of the Rio Grande applies to all irrigation projects. The data on total dissolved solids cited in Table 5 were for the period prior to 1936. Later comparable data[11] show some improvement in the salt balance in this area. Table 6 shows that change in total dissolved solids for some of these same stations for the period from 1931 through 1949.

Of greater interest is the fact that operation of the project during 15 years following publication of the data for 1936 showed the situation to be improving.

[9] "The Rio Grande Joint Investigation," National Resources Planning Committee, Part VI, Vol. 1, pp. 458–463.

[10] Consulting Eng., Austin, Tex.

[11] *Water Bulletin No. 19*, 1949 International Boundary and Water Comm., El Paso, Tex., pp. 63–64.

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